

UNITED STATES PATENT APPLICATION

TITLE: A SYSTEM AND METHOD FOR ANALYZING A QUERY AND GENERATING RESULTS AND RELATED QUESTIONS

INVENTOR: Mohammed S. Anwar

RELATED APPLICATION

This application claims provisional priority to United States Provisional Application Serial No. 60/189,925 filed 16 March 2000.

BACKGROUND OF THE INVENTION

1. **Field of the Invention**

The present invention relates to a system and method for analyzing a user query or natural language query and generating a results and related questions.

More particularly, the present invention relates to a system and method for enhancing information retrieval from a user posed query (Boolean or natural language) including determining keywords associated with the query, producing a result corresponding to the query, generating terms related to the keywords, supplying the keywords and terms to a data mining routine, generating related results and/or information and questions associated with additional results and/or information related to the query, and displaying the results and questions, which the user can then activated and/or investigated.

2. **Description of the Related Art**

Current web searching generally involves construction of a query by a user that is then sent via an information infrastructure such as the internet or world wide web to an application site for processing. The processing site, typically a search engine site, then obtains a set of sites on the infrastructure that have information relating or corresponding to the query. The search engine site can also rank the information containing-sites relative to some particular internal ranking procedure. However, search engines and the sites devoted to them are currently ill prepared to take advantage of information deposited in large database especially multi-dimensional database such as OLAP database and are ill prepared

to delve deeply into data to find other information that may be of interest to a user.

This other information is generally contained in databases that often require sophisticated routines to act as intermediaries so that the search engine, and ultimately the user, can extract meaningfully data and information from them. The intermediaries are generally of two types: middleware interfaces (MWIs) and data mining routines or algorithms (DMRs). MWIs provide information about data in the data database, *e.g.*, variable lists, type of data preprocessing (averages, means, standard deviations, *etc.*), data storage criteria and classification, *etc.* DMRs provide mechanisms for extracting data from the database using routines to further process and classify data in the database. For data mining routines to work properly, they need the actual records or database layout in order to construct data manipulations and ranking, *e.g.*, construction of a decision tree prior to performing a ranking of the data in the decision tree. MWIs exist for relational database and in a co-pending application, the inventor described a MWI for multi-dimensional database such as OLAP database, United States Patent Application Serial No. 09/713,674, filed 15 November 2000, incorporated herein by reference.

Thus there is a need in the art for a system that will allow a user to utilize data stored in diverse databases more effectively and to provide the user with a method for enhancing and/or expanding the richness of data and/or information corresponding to or related to a user's query and/or to refine the query to obtain results of interest to the user.

SUMMARY OF THE INVENTION

The present invention relates to a method for analyzing a query and generating related results including determining keywords associated with the query, polling a database to determine terms related to the keywords, supplying the keywords and terms (all or some) to a data mining routine and generating a results related to the query and questions for refining, expanding or enhancing retrieved information.

The present invention also provides a method for enhancing information retrieval content from a query including retrieving direct data responsive to the query, extracting query element from the query, inputting the elements to a data mining routine, and outputting

results from the data mining routine, where the results include related data and suggested questions for enhancing or refining retrieved results.

The present invention also provides a system for enhancing query information retrieval content, where the system includes a remote digital processing unit (rDPU), a query information retrieval content enhancing server (QIRCES), a database server (DBS), an information infrastructure such as a local area network (LAN), a wide area network (WAN) or a global information infrastructure (GII) interconnecting the rDPU and the servers. The rDPU includes a query generator and communication hardware and software for interacting with the servers over the information infrastructure. The QIRCES includes query information content enhancing software comprising a scheduler, a query parser, a user profiler, a database, a query/results database (qrDB), middleware interface (MWI), data mining algorithms or routines (DMRs), a library of database interfaces, an email controller, communication hardware and software and visualization software, and an expert. And, the DBS includes an informational database (iDB) and database services such as OLAP services for an OLAP database and SQL services.

The present invention also provides a method for analyzing a query and generating related results including forming a query, inputting the query to a DB, outputting results from the DB corresponding directly to the query, extracting query elements from the query, where the element comprises keywords and optionally constraints, generating related query elements comprising related keywords and optionally related constraints, inputting the elements and/or related elements to a DMR and outputting related results and questions from the DMR for query information retrieval content refinement.

The present invention also provides a method for analyzing a query and generating related results and refinement questions including determining query element associated with the query, polling a database to determine related query elements, selecting some or all of the elements and/or related elements, supplying the selected elements and/or related element to a data mining routine, generating related results and questions from the DMR for query information retrieval content refinement and outputting the related results and questions for

user interaction.

The present invention also provides a system including a middleware interface, a data mining communication protocol, a database communication protocol, a query element classification protocol designed to determine query elements (keywords and constraints) from a query and classify the elements according to a classification protocol compatible with a given database, a related query element routine, which generates related query elements based on the element classification and interaction with the database, a communication protocol where the elements and related elements submitted to a data mining routine, a receiving routine to receive results from the data mining routine and a presentation routine where the results and questions for refining the query results from the data mining routine are presented to a user in a predetermined statically significant order so that the user can enhance the information retrieval content of his/her original query.

The present invention also provides a method for enhancing query information retrieval content including: obtaining a query comprising at least one keyword and optional constraints including a containment constraint, a grouping constraint, a connector constraint or a data constraint; generating at least one related keyword and optionally related constraints; obtaining results and/or information for the query "as is"; generating related results and/or information and at least one question related to the query via the operation of a data mining routine; displaying the results and/or information, the related results and/or information and questions; selecting a question; generating question results and/or information and sub-questions; displaying the question results and/or information and sub-questions; and repeating the last three steps to form a query-by-question path. The method can also include the step of saving the path. The method can also includes comparing saved paths.

DESCRIPTION OF THE DRAWINGS

The invention can be better understood with reference to the following detailed description together with the appended illustrative drawings in which like elements are numbered the same:

Figure 1 depicts a block diagram of a preferred overall system of this invention for enhancing information content retrieval from a query;

Figure 2 depicts a block diagram of a preferred embodiment of a system communication protocol of the system of Figure 1;

Figure 3 depicts a block diagram of a preferred system architecture of the system of Figure 1;

Figure 4 depicts a screen image of a preferred embodiment of a user interface of the present invention showing a preferred embodiment of a natural language query input screen;

Figure 5 depicts a screen image of a preferred embodiment of a user interface of the present invention showing a preferred embodiment of a Boolean query input screen;

Figure 6 depicts a screen image of a preferred embodiment of a user interface of the present invention showing a preferred embodiment of a search results screen; and

Figure 7 depicts a screen image of a preferred embodiment of a user interface of the present invention showing a preferred embodiment of result specific screen.

DETAILED DESCRIPTION OF THE INVENTION

The inventor has found that a system and method for enhancing retrieved informational content from a query-based search format can be constructed where the system and method returns not only results and/or information related directly to the query, but also returns results and/or information related to or associated with the query. The inventor has found that this system and method can be implemented on a distributed digital processing environment, where the environment includes remote digital processing units (rDPUs) and server digital processing units (sDPUs or Servers) communicationally interconnected via an information infrastructure including a global information infrastructure (GII) such as the internet or the world wide web, or a local network or LAN.

The present invention broadly relates to a system and method for enhancing the results and/or informational content retrieved from a query, whether the query is a Boolean query or a natural language query. The results and/or informational content is enhanced by running one or more data mining routines against the query to generate related data and one or more

possible sub-queries that may be of interest to the user.

The present invention broadly relates to a method for enhancing the results and/or informational content retrieved from a query including receiving a query, obtaining results and/or information directly related to the query, submitting the query to one or more data mining routines which generate results and/or information related to the query and generate one or more options or sub-queries for refining the query or for investigating results and/or information related to the query or that the system determines may be of interest to the user. The related data and sub-queries are presented to the user in a list or page format so that the user can review and/or investigate the data or sub-queries by clicking on a desired related data result or a desired sub-query. When a user selects a sub-query, the system will act on the sub-query and generate results and/or information related to the sub-query as well as sub-sub-queries based on the processing the sub-query. Thus, the user can be walked down a query-by-question pathway to improve result and information content derivable from any given query.

The system includes routines to receive a query and to post the query "as is" to a DB. If the query is a natural language query, then the system includes routines to extract elements from the query. The system also includes routines to determine related query element based on the query element (keywords and connectors). Once the system has the query elements and related query elements, the system passes these elements to one or more data mining routines (DMRs), where the all of the elements, or some selected elements, are used in each DMR to generate related results comprising related results and/or information and one or more suggested sub-queries for refining and enhancing the information content derived from the query. The related results and suggested sub-queries can be presented to the user as an active list or on a page-by-page basis. Although the DMRs can communicate with databases, including without limitation multidimensional databases (MDDBs), relational databases, hierarchical databases or the like, directly, the preferred communication pathway involves an intermediary called a middleware interface as described in co-pending application United States Patent Application Serial No. 09/713,674, filed 15 November 2000, incorporated

herein by reference.

The system can also include a database for storing queries and results. The system can also include routines for running a user profile against the stored queries and results to inform a user of results and/or information that the user may find of interest based on the user's profile. The system can also include routines for forming user displayable screens or pages devoted to frequently submitted queries, interesting data resulting from queries, or the entire contents of the query/results database. The system can also include routines for performing data analysis and manipulation of data in the query/result database alone or in conjunction with data analysis and manipulation of data from Dbs. The system can also include background routines that search DBs and other databases for results and/or information that may be of interest to users based on the profiles in the user profile database. The user profile database can be categorized or classified based on a scheme that groups users into categories or classes so that background data mining protocols can be tailored to derive results and/or information for all users or for each category or class. The system can also include user interactive procedures for ranking the relevancy of related data and sub-queries to further refine user profiling and enhance and enrich a user's access to results and/or information of interest to the user. The system can also includes an email interface for providing the results in an email context.

For internet implementation, the system of the present invention comprises user rDPUs and sDPUs including an application server (asDPU) and a database server (dbsDPU). The rDPUs include a browser which is the communication conduit between the user and the asDPU, which is generally based on HTML or some other similar communication protocol. The asDPU communications with the dbsDPUs either directly or via a MWI using standard database communication protocols.

Suitable digital processing units, both remote DPUs and Servers, can be any digital processing device including, without limitation, digital processing devices manufactured by Dell Corporation, Compaq Corporation, Intel Corporation, Motorola Corporation, Texas Instruments, Inc., IBM, AMD, Cyrix, or any other manufacturing of digital processing

devices. The memory can be any memory compatible with the particular digital processing device.

Suitable operating systems include, without limitation, windowing operating systems, UNIX based operating systems or any other operating system. Suitable communication hardware and software can be any software and hardware that supports any narrow band or wide band communication protocols, with wide band, high speed communication protocols being preferred.

Suitable data mining routines or algorithms that can be used by the system of this invention include, without limitations, a chi squared DMR, a correlation DMR, a decision tree DMR, a market basket type DMR, a naive Bayes DMR based on Bayesain statistics, an association DMR, a cluster DMR or other similar data mining routines or algorithms or mixtures or combinations of one or more DMRs, some of which are described in co-pending United States Patent Application Serial No. 09/713,674, filed 15 November 2000, incorporated herein by reference and other are well-known public domain data mining routines.

User Interface

Login Page

When a user connects to the QIRCES system for the first time, the system prompts the user for a unique user ID and password, with standard password reentry to insure proper password assignment. Once a user ID and password has been established and stored by the system, the next time the user connects to the system, entry of the user ID and password will allow the user access to the system. If the user is a GII user using a browser to connect to the QIRCES server, then the user can elect to have authentication processing saved in browser cookie file. When the user registers (first time user), the user can elect to save the login file (user ID and password) in a cookie. Of course, the user can elect this option any time he/she connects to the system. If the user chooses to save her/his login profile in a cookie file, then the Login Page will not appear the next time the user connects to the system. If the user elects not to have a cookie file containing the necessary login information or if the

user's browser does not support cookies, then the Login Page will appear every time the user connects to the server and the user will have to complete the standard login procedure.

User's Home Page

In a preferred implementation of the QIRCES system of this invention, each user would have a home page on the server, which is created when a user first registers with the QIRCES system. Each time the user connects to the QIRCES system after registration, the user goes directly to his/her home page. The user can customize her/his page. The home page is used by the user to save results to set and modify preferences and to view postings from the system that fit the user's profile or that the system determines may be of interest to the user.

After the user passes authentication, the browser displays the user Home Page. The main section of this page allows the user to navigate projects, favorites, preferences, view hot news, recent projects, server notifications, *etc.* If the browser supports frames, then the page can be frame-based for further convenience and functionality. This page preferably includes navigation and information areas or domains. The first domain or area, which can be located in the left 20% of the page by default (changeable), can include links to: (1) the main section of the user's Home Page; (2) the user's workplace; (3) a favorites page; and (4) the user's preferences.

If the user has an email account on the system, the server administrator can provide a web-based interface to a user's mailbox. This interface can be included in the user's Home Page and there can be a link to this interface in the navigation area of the Home Page. The user's workplace link has child links to the user's recent projects, a new project wizard and other workplace related functions. The user's favorites page link includes user defined child links organized in folders that in their turn can have child links and folders. The server administrator can predefine some links and folders, while other can be defined by the user. The user's preferences link includes child links to different preference sets such as global preferences, mailbox preferences, query construction preferences, results preferences, *etc.*

User's Workplace

In a preferred embodiment of the QIRCES system, the system creates for each user a user workplace. The workplace is used by the user to create projects that allow the user to gather information on an as-needed basis or a periodic basis. The system saves information about each user project for review, retrieval, modification, analysis or the like. Via workplace preferences, the user can choose the type of information displayed when the user workplace page is opened, *e.g.*, display recent projects sorted by last access date or display only the latest accessed projects or display the most frequency accessed projects. The workplace page can also include a link to a new project wizard that allows the user to create a new project. When working with a project, the user can switch the workplace interface between two modes: (1) a confirmatory mode and (2) an exploratory mode. The user can work in either mode independently.

The confirmatory mode allows the user to go directly a particular database or database site such as an MDX cube and pose a query to that particular database, *i.e.* the confirmatory mode is a single DB-single query mode. If the user wants to work with different cubes or queries, the user must create a different project, one for each cube and/or query.

The exploratory mode allows the user to pose a query to any number or database or to all databases that are accessible to the system and contain information relevant to the posed query. The exploratory mode uses a search engines and surfer type interface. Results are then displayed for the user's review.

There are two kinds of searches: Boolean searches and Natural Language searches. The Natural Language search is preferable English; however, the Natural Language interface can support other languages. When operating in English, the Natural Language search mode is sometimes called the English Language search mode. Boolean searching is based on a set of constraints. Each constraint includes a text field (keyword – word or words), a containment option (must contain, must not contain, should contain, *etc.*), a grouping option (the word(s), the phrase, *etc.*), a connectors connecting text fields (and, or, not, andnot, nor, *etc.*) and a data option having the following variants: (1) filter; (2) dimension member; (3) dimension, drilled down to the level of member; (4) member's child members; and (5) drilled

down parent member. Search engine results can be formatted, sorted or categorized as desired.

Search Engine Interface

In a preferred embodiment of the system of this invention, the system includes a search engine interface (SEI), which is based on popular search engine concepts such as those found in search engines like AltaVista, Excite, or the like. The SEI allows the user to pose queries in a variety of search formats including Boolean queries, Natural Language queries, predefined queries and DB structured queries. Using the SEI, the user will construct a query in a manner similar to the way the user would construct queries in a typical search engine. Once the user constructs a query, the SEI allows the user to submit the query by hitting enter or a search button associated with the SEI. Such an SEI is described in greater detail in conjunction with the description of Figures 6A&B and 7A&B.

Search Engine Query Result

Once the user has constructed and submitted a query, the SEI presents the results of the query and the query refining process (DMR results and sub-queries) a list format similar to results presented in a typical search engine. Although each list member includes a brief textual description, it does not point to a URL as it would in a typical search engine, but instead is a pointer into a particular results section of the query results as shown in Figure 7A. The first or top query result section contains results and/or information derived from the query "as is" along with certain obvious refinements, *e.g.*, time, location, product, *etc.* Subsequent result sections include results and/or information from the operation of each DMR on the query elements and related elements. These results include simple refinements such as a particular type of a broad class of a keyword (*e.g.*, coke from the keyword drink) as well as more complex refinements that actually amount of a new refined query or question. When a more complex refinement is selected by the user, the user will be given results and/or information from the refinement that can include simple refinements as well as more complex refinements, *i.e.*, another query or question. Thus, the user can progress down a query-by-question path viewing results along the way in a cross-tabulated format and a

graphical format as shown in Figure 7B.

Surfer Interface

In another preferred embodiment of the system of this invention, the interface does not include a search engine query construction and submission construct or includes a surfer switch that permits the user to toggle between the SEI and the surfer interface. The surfer interface permits the user to bypass the query construction and submission window and instead to surf and/or view results of queries that the user has already submitted or that have been previously submitted by other users. These results can be all results in the application database or a profile restricted or filtered set of results based on user preferences. These results of existing queries can be categorized as follows: (1) predefined queries defined by site administrators, database administrators or the like; (2) popular user queries; (3) queries that are created as a result of background data mining operations; or (4) all results in the system results database.

Email Interface

In another preferred interface, the user can construct and submit queries and await results via an email interface such a SMTP or WAP. Because certain queries posed by a user may require considerable processing time, the user can chose to submit the search and await results notification via the email interface. Alternatively, the user can fill out a basic template providing information about the type of information the user in interested in to create a user profile corresponding to the information entered into the template by the user. The user can specify what frequency of email notification the user desires, *e.g.*, very frequent, frequent, or infrequent. The user will be able to fine tune the email frequency that is optimal for the user and the user can fine tune the content of the information the user is interested in. The email messages will include a result section as described in connection with the Search Engine Query Results section and Figure 7A herein. Thus, the email interface, which can be used in conjunction with the SEI or the surfer interface or all by itself, allows the user access to results and/or information of interest to the user on a time frame definable by the user. Thus, the user can be notified by email anytime a search that

fits the user's profile is submitted or only when the results of a query fitting the user's profile includes interesting results. By interesting results, the inventor means results that show a high direct or inverse correlation with other data, that show data significantly impacted by data that fits the user's profile or any other statistically significant correlations involving data that fits the user's profile.

Back End Processing

In another preferred embodiment of the system of this invention, the system includes back end processing routines for mining the data that may be of interest to a particular user or to the user community in general. Thus, the system on the application server(s) can track user activity and preferences so that the system routines can better tailor results and/or information content for each user or the user community in general. The system will track user behavior including, without limitation, search habits, query structures, results ratings, site preferences, feature preferences, and/or other personal preferences as well as user community habits including, without limitation, popular query formats, popular sites, popular system components, or the like. The system uses the tracked data to improve system features and/or facilities and/or to improve retrieved informational content for the whole community, a part of the community and/or a particular user in the community.

Query-by-Question Pathways

One powerful aspect of the system of this invention is the ability for the system to walk a user down a path of results and/or information related to or derived from a single query. As each DMR returns results and/or information derived from the original query and generates one or more sub-queries that may be of interest to the user, the user can embark on an exploratory survey of results and/or information derived from each sub-query and each sub-query generated by the DMR from a selected sub-query. Thus, the user can be directed on a question by question basis to results and/or information related many level down a query-by-question pathway. Of course, each pathway will be different depending on the particular sub-query selections made by the user.

System Architecture

The system is preferably designed to run on one or more dedicated application servers that receive queries, retrieve direct results to the queries and trigger DMRs to ferret out related results and/or information. As interesting relationships are found, the system stores the query and the results in a database. The system periodically analyzes the database to determine whether new databased results fit a user profile and notifies the user via the email interface.

One preferred architecture for the system of this invention, breaks the system into three basic levels: Presentation; Application and Data.

Presentation Level

A preferred presentation level for systems implemented on a GII includes components which run on the user's rDPUs under a browser such and Internet Explore or Netscape. Preferably, the browser supports HTML, DHTML, Java-script, frames, VRML and Java-applets (NN4, IE4, and VRLM plugins) or the like. Of course, the browsers support all basic feature such as site-surfing, login, search, *etc.* For LAN based implementations, the rDPUs would use any custom software for query construction and submission and LAN communications.

Application Level

A preferred application level for systems implemented on a GII includes components running on a server under a server OS such as UNIX based operating system and NT based operating systems, which include GII services for server to server and server to user connections and communications such as IIS from MicroSoft or the SMTP, WAP or similar protocols. Application servers are connected with the data servers via ethernet or other wide band data communication protocol for LAN based systems or via wide band communication protocol for GII implementation. Moreover, the application server and the database server can be the same server or can be implemented on the same internet site.

Data Level

A preferred data level for systems implemented on a GII includes software components running on a database server under a server OS such as UNIX based operating

system and NT based operating systems, which include GII services for server to server and server to user connections and communications. In addition, the database server includes a database, which can be any type of database including, without limitations, relational databases or multidimensional database such as OLAP database. In addition to the OS and to other standard software, the database server will include database service software including database communication protocol software such as SQL software (e.g., MS SQL Server) and MDDDB service software such as MS OLAP Services.

Detailed Description of the Drawings

Referring now to Figure 1, a preferred embodiment of the system of the present invention, generally **100**, is shown to include a rDPU **102** which also includes an operating system **104**, a browser **106** and communication software **108**. Of course, the rDPU **102** also includes standard hardware components such as a processor, memory, mass storage devices, and peripherals (not shown). The rDPU **102** is in two-way communication with a application server **130** via an information infrastructure such as a LAN (local area network), a WAN (wide area network) or a global information infrastructure **120** using a communication protocol **122** such as HTML, XLM, GIF, Jave3D, TCP/IP, or the like. The application server **130** includes an operating system **132**, active server pages **134**, pivot table services **136**, DMRs **138**, a profiler **140**, a database **142**, a middleware **144** and communication software **146**. As with the rDPU **102**, the application server **130** includes standard hardware components such as a processor, memory, mass storage devices, and peripherals (not shown). The application server **130** is in two-way communication with a database server **160** via the information infrastructure **120** using a protocol **124** such as MDX or OLE DB. The database server **160** includes an operating system **162**, services **164** including database services such as OLAP services associated with OLAP mulitdimensional databases and SQL services, and communication software **166**.

Referring now to Figure 2, a preferred architecture, generally **200**, for the system of this invention is shown schematically to include a presentation level **202**, a business level **220** and a data level **260**. The presentation level **202** involves interaction with the user at the

rDPU 102 of Figure 1 using a communication protocol or combination of protocols 204 such as HTML, DHTML, pictures, JavaScript, Java3D, etc. over the GII 112 of Figure 1 and also involves text based message receiving and sending 206. The business level 220 includes an IIS 222, in two-communication with an ASP 224 and a SMTP 226. The business level 220 also includes a query information content enhancing sub system (QIRCES) 228 including a query information content enhancing controller 230, a DMR library 232, a library of database interfaces 234, a profile controller 236, experts 238, a communication/visualization controller 240 and an e-mail controller 242. The ASP 224 is in two-way communication with QIRCES 228 and a component of the ASP 224 is in two-way communication with the communication/visualization controller 240 of QIRCES 228. The SMTP 226 is in two-way communication with the e-mail controller 242. The data level 260 includes DB services 262 such as OLAP services for OLAP multidimensional databases and SQL services 264. The library 234 of QIRCES 228 is in two-way communication with the DB services 262 and the SQL services 264. The present structure is applicable to any DB including MDDBs, relational databases, hierarchical database or the like and the MWI would be a middleware product designed to interface with the particular database being accessed.

Referring now to Figure 3, a block flowchart of a preferred query informational content enhancing method of this invention, generally 300, is shown to start with the user constructing a query or search question step 302. The query can be constructed using any type of software that is capable of interacting with a database, including without limitation, database front ends, a search engine accessible for a network such as a internet or intranet, a spread sheet program such as Quattro Pro, Exel, etc. or any other software program that permits query construction and submission to a database. After the query is constructed (generally, typed into a text box in a screen), the query is forwarded over a network in a query send step 304 to an application server that captures the query in a query capture step 306. The application server can be a server in an internet environment like a site on the world wide web or a digital processing unit in an intranet or LAN. The application server can be the same or different from the digital processing unit or server upon which the

database is resident.

Once captured, the application server determines whether the query is a natural language query in a conditional test step 308. If it is a natural language query, then the method 300 transfers control along a YES branch 310 to a pre-process query step 312, where keywords and connectors are extracted from the natural language query. Once keywords and connectors are extracted from the natural language query, control is transferred to a forward query as is to a database step 314, where results and/or information directly related to the query is gathered. If the query is not a natural language query, but a Boolean query or other query that comprises keywords and connectors, then control is transferred along a NO branch 316 to the forward query as is step 314. Next or simultaneous with the as is query forward step 314, related keywords and/or connectors are generated in a generate step 317. Next, the query components (keywords and connectors) and related components (related keywords and/or connectors) are submitted to one or more DMRs in a submit step 318.

The DMRs operate on the query terms to generate a request or a plurality of requests for results and/or information from a database in and sends the request(s) to a middleware interface which facilitates data extraction from the database in a send requests to MWI step 320. For relational database, the MWI can be one of a variety of MWI products available on the open market including, without limitations, CocoBase from Thought, Inc., DataDirect SequeLink from Merant, DB2 Universal Database from IBM, dbAnywhere Server from Symatec, DbGen from 2Link Consulting, Inc., and other middleware products listed at www.javaworld.com/javaworld/tools/jw-tools-datamid.html or similar internet sites. For multi-dimensional databases, including OLAP databases, the middleware product is preferably the product disclosed in co-pending United States Patent Application Serial No. 09/713,674, filed 15 November 2000, incorporated herein by reference.

Once the MWI receives the requests in a MWI receive step 322, the MWI constructs appropriate database requests in a construct step 324 and sends the DB requests onto the database in a send DB requests step 326. Once the database receives the requests in a receive step 328, the database constructs results corresponding to the requests in a construct step 330,

and sends the results onto the MWI in a send results step **332**. Once the MWI receives the DB results in a receive step **334**, the MWI reviews the results and the MWI requests from the DMR and determines whether any additional requests are required to complete the MWI requests in a conditional step **336**. If additional requests are required to produce a complete response to the DMR requests, then control is transferred along a YES branch **338** to the construct step **324** which repeats steps **326-336**.

Once the conditional step **336** determines no additional data are required to complete the MWI requests, then control is transferred along a NO branch **340** to a post-processing conditional step **342**, where the MWI checks to determine whether the DB responses required post-processing or analysis prior to construction of DMR responses. If post-processing is required, then control is transferred along a YES branch **344** to a post-processing step **346** and then to a construct DMR responses step **348**; otherwise, control is transferred along a NO branch **350** directly to the construct step **348**, where the DB results and any post-processing of the results are set forth in responses to the DMR requests and forwarded to the DMR in a send step **352**. Next, the DMR receives the DMR responses in a receive step **354** and constructs User responses in a construct step **356**. The user responses are then sent and displayed for the user in send step **358** and display step **360**, respectively.

Referring now to Figure 4, a block flowchart of a preferred user result interaction method of this invention, generally **400**, is shown to include a display format conditional step **402**, where the routines check to determine whether the user prefers to see a condensed list of the results or prefers to see the result in page format from the get go. If the user prefers the list format, then control is transferred along a LIST branch **404** to display results list step **406**. Once the list is displayed, the user can select a given result by clicking on the result selector in a select step **408**. Once selected, the routine displays a page format positioned at the selected result in a display page format step **410**. If the user prefers the page format from the get go, the control is transferred from the conditional step **402** along a PAGE branch **412** to the page format step **410**, except that the page is positioned at the first result instead of at a selected result. The results page includes results and questions related to the query

generated by DMRs which can be toggled on and off to allow the user to follow or construct a query-by-question path through the related query data. When the user selects a given refinement or question, that question becomes a new query, which gives rise to new results and new questions. This process can be continued until the user either finds the result he/she desires or determines that the path is not leading to any results of interest. The system can also save the query-by-question path, which can be saved simply as a composite query including all of the keywords and constraints associated with the final result in the path.

Once in the page format either at the start of the results or at some selected position within the page displayed results, the user can select a give query refinement by clicking on a given query refinement selector in a select refinement step 414. The method 400, then checks to see if the selected refinement requires additional processing in a conditional step 416. If additional processing is required, then control is transferred along a YES branch 418 to a goto step 420, which transfers control to step 304 of Figure 3. After the method set forth in Figure 3 completes obtaining results corresponding to the additional processing, control is transferred to a display selected refinement step 422, which is also the step to which control is transferred along a NO branch 424, if additional processing is not needed. Once the selected refinement is displayed, the method 400 check to see if the user wants to exit the routine in an exit test step 426. If the user does not want to exit the method, then control is transferred along a NO branch 428 to the select step 414. If the user does want to exit, then control is transferred along a YES branch 430 to an exit step 432. The user review, displays and analyzes the refinements and the results derived therefrom using the SEI. A preferred SEI results screen display format is shown in Figure 7A&B and described herein.

Figure 4 also illustrates the query-by-question method of this invention. As the user selects a particular refinement and

Referring now to Figure 5A, a first preferred structure, generally 500, of this invention is shown to include a user interface 502, which can be any interface capable of allowing a user to construct a search and submit the search to a database including, without limitation, a spread sheet such as Excel or Quattro Pro, a database front end or any other type of query

construction software routine in active communication with a database. In prior art database searching environments, the user interface **502** would communicate directly with a database; however, in the structure **500** of this invention, an intermediary routine, the QIRCES system, is interposed between the user interface **502** and the database. The QIRCES system **504**.
5 The system **504** includes a QIRCES controller **506**, a query processor **508**, which processes natural language queries to extract keyword and connector, a DMR library **510** and a MWI **512**. Finally, the structure **500** includes a database **514**. The user interface **502** is in two-way communication with the QIRCES controller **506** via communication pathway **516**. The QIRCES components are in two way communication as shown by the pathways **518**, while
10 the controller **506** and the MWI **512** are in two-way communication with the database **514** along pathways **520**. The controller **506** is in communication with the database **514** to transmit the query as is and to receive the as is query results, while the MWI **512** is in communication with the database **514** to transmit and receive information required by each DMR in the DMR library **510**. The structure **500** can be implemented on a single digital processing unit, but is preferably implemented on a distributed processing environment such as an intranet (LAN or the like) or a global information infrastructure (the internet or world wide web).

Referring now to Figure 5B, a block flowchart of a preferred user interaction method of this invention, generally **550**, is shown to include a user interface **552**, which can be any browser software program such as Explorer from MicroSoft, Netscape from Netscape, *etc.* and a search engine program **554** such as Excite, AltaVista, Ask Jeeves, HotBot, Google, Lycos Search, Netscape Search, *etc.* In prior art search engine searching environments, the search engine **554** would communicate directly with a database; however, in the structure **550** of this invention, an intermediary system, the QIRCES system **556**, is interposed between the
25 search engine **554** and the database. The QIRCES system **556** includes a QIRCES controller **558**, a query processor **560**, which processes natural language queries to extract keyword and connector, a DMR library **562** and a MWI **564**. Finally, the structure **550** includes a database **566**. The user interface **552** is in two-way communication with the search engine **554** via

communication pathway 568, which is in two-way communication with the QIRCES controller 556 via communication pathway 570. The QIRCES components are in two way communication as shown by the pathways 572, while the controller 556 and the MWI 562 are in two-way communication with the database 564 along pathways 574. The controller 556 is in communication with the database 564 to transmit the query as is and to receive the as is query results, while the MWI 562 is in communication with the database 564 to transmit and receive information required by each DMR in the DMR library 562. The search engine 554 can optionally be in direct two-way communication with the database 564 via communication pathway 576 and in optional direct two-way communication with the MWI 562 via communication pathway 578. The structure 550 can be implemented on any distributed processing environment such as an intranet (LAN or the like) or a global information infrastructure (the internet or world wide web), but is preferably implemented on a global information infrastructure.

Referring now to Figures 6A and B, an illustrative screen image, generally 600, of a preferred search engine interface to the QIRCES system and/or method of this inventions is shown to include a main window 602. In this figure and the associated figures relating associated with this search engine interface, the interface is shown to operate in the Microsoft Internet Explorer browser. It should be recognized that other browsers can be used as well.

The main window 602 includes a browser banner 604, browser control buttons 606, a set of browser pull down menus 608, a set of active browser icons 610, and an address display area 612 with associated pull down menu button 614 to display previously visited sites. The main window 602 also includes a QIRCES SEI window 620, which illustrates a preferred implementation of the SEI of the present invention. The QIRCES SEI window 620 includes a SEI banner 622 and a set of link buttons 624 to difference pages within the SEI. The link buttons 624 include a home link button 626, a register button 628, a my page button 630, undefined buttons 632, and a contacts button 634. The QIRCES SEI window 620 also includes a select criterion selector 636 with associated pull down menu button 638, a measure

criterion selector **640** with associated pull down menu button **642**, and a data mining criterion selector **644** with associated pull down menu button **646**. The QIRCES SEI window **620** also includes a query construction and submission window **648**. The query window **648** includes a English tab **650** for entering natural language queries in English (or any other language),
5 a Boolean tab **652** for entering Boolean queries, a predefined tab **654**, where the user can form one or more predefined queries or can select from a list of predefined queries, a DB structure tab **656**, where the user can enter queries that are structured for direct interaction with a given database schema and a show field **658** and pull down button **660** for controlling the number of result shown per page in the result windows described herein. The English
10 tab **652** includes a query entry field **662** with associated scroll controls **664** and search submit button **666**.

Looking at Figure 6B, the window **648** is shown with the Boolean tab **652** activated. In the Boolean query construction window format, the window **648** includes a first term entry field **668** with an associated Boolean keyword (word or phrase) entry field **670** and pull down menu button **672** and an associated entry type field **674** and pull down menu button **676**. The
15 window **648** also includes a second term entry field **678** with an associated Boolean keyword control field **680** and pull down menu button **682** and an associated entry type field **684** and pull down menu button **686**. The window **648** also includes a Boolean keyword connector field **688** and associated pull down menu button **690** and a add button **692** to add additional
20 keywords or terms to the query.

Referring now to Figure 7A, the screen image **600** is shown displaying search results and includes the result window **700** having a banner **702** and including the search **704** to which the results apply. The window **700** also includes a first results section **706**, which includes a set of descriptor fields **708** that correspond to the query keywords used in the
25 search with associated toggle or check boxes **710** to toggle the keywords on or off. The first results section **706** also includes a set of proposed refinements **712** and associated toggle or check boxes **714** for turning the refinements on and off. The refinements **712** are simple refinements based on the query "as is" and not from DMR processing. The section **706** also

includes an open button 716, a database identifier field 718, a cube identifier field 720 and a measure identifier field 722. The result first section 706 includes information and refinements that related directly to the query and do not include related or enhanced results and/or information retrieval refinements that are generated via the operation of a DMR. The remaining results section are results that are derived from the operation of a DMR on the query. Thus, a second and third results sections 730 and 732 include results from different DMRs.

The second and third results sections 730 and 732 include a set of primary result identifiers 734 with associated toggles or check boxes 736 some of which are turn on and some of which are turned off, and a set of refinements 738 with associated toggles or check boxes 740. The user can turn toggles or check boxes on or off and then open a given result by hitting the open button 716 associated with the result section of interest. Once the user activates a result by hitting the open button 716 associated with a particular result section, the SEI activates a detailed results screen.

Looking at Figure 7B, an illustrative screen image, generally 750, is shown containing detailed results and offering the user an opportunity to review the results in a cross-tab representation and a graphical representation. The screen 750 includes a detailed results window 752. The window 752 includes an active cross-tab 754 displaying cross tabulated data 756 relating to geographical categories 758, drink categories 760 and years 762. The window 752 also includes a graph 764 showing the displayed cross tabulated data in graphical form. The window 752 also includes a "more like this" active field 766, which sends a request to the QIRCES system to retrieve results like this in the QIRCES database. The window 752 also includes a "use as a template" active field 768 and a "save this query in my home page" active field 770, where the use a template field 768 instructs the QIRCES system to use the query refinement as a template for future queries and the save field 770 instructs the QIRCES system to add the query to the user's home page for latter review.

The window 752 also includes a first button 772 for going to the first result, a previous button 774 for going to the previous result, a next button 776 for going to the next

result, and a last button 778 for going to the last result. The window 752 also includes a rating or ranking protocol 780 shown here to include a Relevant button 782, a Neutral button 784 and a Not Relevant button 786 with a rank result button 788.

5 All references cited herein are incorporated by reference. While this invention has been described fully and completely, it should be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. Although the invention has been disclosed with reference to its preferred embodiments, from reading this description those of skill in the art may appreciate changes and modification that may be made which do not depart from the scope and spirit of the invention as described
10 above and claimed hereafter.

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210